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*CONTENTS*



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## COOPERATION IN RESEARCH[1]

No one can survey the part played by science in the war without reflecting on the ultimate influence of the war on science. Able investigators have been killed or incapacitated, and with them a host of men who might have taken high places in research. Sources of revenue have been cut off, and the heavy financial burdens permanently imposed upon individuals, institutions, and governments must tend to reduce the funds available for the advancement of science. On the other hand, the usefulness of science is appreciated as it never has been before, and some newly enlightened governments have already recognized that large appropriations for research will bring manifold benefits to the state. The leaders of industry have also been quick to appreciate the increased returns that research renders possible, and industrial laboratories are multiplying at an unprecedented rate. The death of available investigators, and the higher salary scale of the industrial world, have seriously affected educational institutions, members of whose scientific staffs, inadequately paid and tempted by offers of powerful instrumental equipment, have been drawn into the industries. On the other hand, industrial leaders have repeatedly emphasized the fundamental importance of scientific researches made solely for the advancement of knowledge, and the necessity of basing all great industrial advances on the results of such investigations. Thus they may be expected to contribute even more liberally than before to the development of laboratories organized for work of this nature. Educational institutions are also likely to recognize that science should play a larger part in their curriculum, and that men skilled in research should be developed

[1] Address given before the Royal Canadian Institute, Toronto, April 9, 1919.

in greatly increased numbers. The enlarged appreciation of science by the public, the demand for investigators in the industries, and the attitude of industrial leaders of wide vision toward fundamental science, should facilitate attempts to secure the added endowments and equipment required.

On the whole, the outlook in America seems most encouraging. But the great advance in science that thus appears to be within reach can not be attained without organized effort and much hard work. On the one hand, the present interest of the public in science must be developed and utilized to the full and on the other, the spirit of cooperation that played so large a part during the war must be applied to the lasting advantage of science and research. Fortunately enough, this spirit has not been confined within national boundaries. The harmony of purpose and unity of effort displayed by the nations of the Entente in the prosecution of the war have also drawn them more closely together in science and research, with consequences that are bound to prove fruitful in coming years.

The Honorable Elihu Root, who combines the wide vision of a great statesman with a keen appreciation of the importance and methods of scientific research, has recently expressed himself as follows:

> Science has been arranging, classifying, methodizing, simplifying everything except itself. It has made possible the tremendous modern development of the power of organization which has so multiplied the effective power of human effort as to make the differences from the past seem to be of kind rather than of degree. It has organized itself very imperfectly. Scientific men are only recently realizing that the principles which apply to success on a large scale in transportation and manufacture and general staff work apply to them, that the difference between a mob and an army does not depend upon occupation or purpose but upon human nature; that the effective power of a great number of scientific men may be increased by organization just as the effective power of a great number of laborers may be increased by military discipline.

The emphasis laid by Mr. Root on the importance of organization in science must not be misinterpreted. For many years he has been president of the board of trustees of the Carnegie Institution of Washington, and an active member of its executive committee. Thus kept in close touch with scientific research, he is well aware of the vital importance of individual initiative and the necessity of encouraging the independent efforts of the original thinker. Thus he goes on to say:

> This attitude follows naturally from the demand of true scientific work for individual concentration and isolation. The sequence, however, is not necessary or laudable. Your isolated and concentrated scientist must know what has gone before, or he will waste his life in doing what has already been done, or in repeating past failures. He must know something about what his contemporaries are trying to do, or he will waste his life in duplicating effort. The history of science is so vast and contemporary effort is so active that if he undertakes to acquire this knowledge by himself alone his life is largely wasted in doing that; his initiative and creative power are gone before he is ready to use them. Occasionally a man appears who has the instinct to reject the negligible. A very great mind goes directly to the decisive fact, the determining symptom, and can afford not to burden itself with a great mass of unimportant facts; but there are few such minds even among those capable of real scientific work. All other minds need to be guided away from the useless and towards the useful. That can be done only by the application of scientific method to science itself through the purely scientific process of organizing effort.

It is plain that if we are to have effective organization in science, it must be adapted to the needs of the individual worker, stimulating him to larger conceptions, emphasizing the value of original effort, and encouraging independence of action, while at the same time securing the advantages of wide cooperation and division of labor, reducing *unnecessary* duplication[2] of work and providing the means of facilitating research and promoting discovery and progress.

A casual view of the problem of effecting such organization of science might lead to the conclusion that the aims just enumerated are mutually incompatible. It can be shown

2 Some duplication is frequently desirable.

by actual examples, however, that this is not the case, and that an important advance, in harmony with Mr. Root's conception, is entirely possible.

It goes without saying that no scheme of organization, effected by lesser men, can ever duplicate the epoch-making discoveries of the Faradays, the Darwins, the Pasteurs, and the Rayleighs, who have worked largely unaided, and who will continue to open up the chief pathways of science. Even for such men, however, organization can accomplish much, not by seeking to plan their researches or control their methods, but by securing cooperation, if and when it is needed, and by rendering unnecessary some of the routine work they are now forced to perform.

Let us now turn to some examples of organized research, beginning with a familiar case drawn from the field of astronomy, where the wide expanse of the heavens and the natural limitations of single observers, and even of the largest observatories, led long ago to cooperative effort.

In the words of the late Sir David Gill, then Astronomer Royal at the Cape of Good Hope, the great comet of 1882 showed "an astonishing brilliancy as it rose behind the mountains on the east of Table Bay, and seemed in no way diminished in brightness when the sun rose a few minutes afterward. It was only necessary to shade the eye from direct sunlight with a hand at arm's length, to see the comet, with its brilliant white nucleus and dense white, sharply bordered tail of quite half a degree in length." This extraordinary phenomenon more brilliant than any comet since 1843 marked the beginning of celestial photography at the Cape of Good Hope. No special photographic telescope was available, but Sir David enlisted the aid of a local photographer, whose camera, strapped to an equatorial telescope, immediately yielded pictures of exceptional value. But even more striking than the image of the comet itself was the dense background of stars simultaneously registered upon these plates. Stellar photographs had been taken before, but they had shown only a few of the brighter stars, and no such demonstration of the boundless possibilities of astronomical photography had ever been encountered. Always alive to new opportunities and keen in the appreciation of new methods, Sir David adopted similar means for the mapping of more than 450,000 stars, whose positions were determined through the cooperation of Professor Kapteyn, of Groningen, who measured their images on the photographs.

Stimulated by this success, the Henry brothers soon adapted photographic methods for star charting at the Paris Observatory, and in 1887 an International Congress, called at Sir David's suggestion, met in Paris to arrange for a general survey of the entire heavens by photography. Fifty-six delegates of seventeen different nationalities resolved to construct a photographic chart of the whole sky, comprising stars down to the fourteenth magnitude, estimated to be twenty millions in number. A standard form of photographic telescope was adopted for use at eighteen observatories scattered over the globe, with results which have appeared in many volumes. These contain the measured positions of the stars, and are supplemented by heliogravure enlargements from the plates, estimated, when complete for the entire atlas of the sky, to form a pile thirty feet high and two tons in weight.

The great cooperative undertaking just described is one that involves dealing with a task that is too large for a single institution, and therefore calls for a division of labor among a number of participants. It should be remembered, however, that a very different mode of attacking such a problem may be employed. In fact, although the difference between the two methods may seem on first examination to be slight, it nevertheless involves a fundamental question of principle, so important that it calls for special emphasis to any discussion of cooperative research.

One of the great problems of astronomy is the determination of the structure of the sidereal universe. Its complete solution would involve countless observations. Nevertheless, Professor Kapteyn, the eminent Dutch astron-

omer, resolved many years ago to make a serious effort to deal with the question. In order to do so, as he had no telescope or other observational means of his own, he enlisted the cooperation of astronomers scattered over the whole world.

In organizing his attack, he recognized that the inclusion of only the brighter stars, or even of all those contained in the International Chart of the Heavens, would not nearly suffice for his purpose. He must penetrate as far as possible into the depths of space, and therefore hundreds of millions of stars are of direct importance in his studies. Moreover, it is evident that if he were to confine his attention to some limited region of the sky, he could form no conclusions regarding the distribution of stars in other directions in space or such common motions as might be shown, for example, by immense streams of stars circling about the center of the visible universe.

As the measurement of the positions, the motions, the brightness, and the distance of all the stars within the reach of the most powerful telescopes would be a truly Utopian task, Professor Kapteyn wisely limited his efforts, and at the same time provided a means of obtaining the uniformly distributed observations essential to the discussion of his great problem. His simple plan was to divide the entire sky into a series of 206 selected areas, thus providing sample regions, uniformly spaced and regularly distributed over the entire sphere. Conclusions based upon the observation of stars in these areas are almost as reliable, so far as large general questions of structure and motion are concerned, as though data were available for all the stars of the visible sidereal universe.

As already remarked, Professor Kapteyn depends entirely upon the volunteer efforts of cooperating astronomers in various parts of the world. One of these astronomers assumes such a task as the determination of the brightness of the stars, of a certain range of magnitude, in the selected areas. Another deals with their positions and motions, another with their velocities measured with the spectroscope, etc. Each observer is able to take a large number of selected areas, covering so much of the sky that he may separately discuss the bearing of his results on some important problem, such as the distribution of the stars of each magnitude with reference to the plane of the Galaxy, the motions in space of stars of different spectral types, the velocity and direction of the sun's motion in space, the dependence of a star's velocity upon its mass. Moreover, each observer is free to use his utmost ingenuity in devising and applying new methods and instruments, in increasing the accuracy of his measures, and in adopting improved means of reducing and discussing his observations. He also enjoys the advantage of observing stars for which many data, necessary for his own purposes, have been obtained by other members of the cooperating group. Outside the selected areas, such data are usually lacking, because so small a proportion of the total number of stars has been accurately observed.

In physics, as well as in astronomy, there are innumerable opportunities for cooperative research. A good illustration is afforded by the determination of the exact wave-lengths of lines in the spectra of various elements, for use as standards in measuring the relative positions of lines in the spectra of celestial and terrestrial light-sources. This work was initiated in 1904 by the International Union for Cooperation in Solar Research, and is now being continued by the International Astronomical Union. The spectrum of iron contains thousands of lines, many of which are well adapted for use as standards. The work of determining their positions was undertaken by the members of an international committee, in accordance with certain specifications formulated by the Solar Union. But those who took part in the investigation were not bound by any rigid rule. On the contrary, they were encouraged to make every possible innovation in the manner of attack, in order that obscure sources of error might be discovered and the highest possible accuracy in the final results attained. The outcome demonstrates most conclusively that organized

effort and freedom of initiative are by no means incompatible. Important instrumental improvements of many kinds were effected, sources of error previously unsuspected were brought to light, and means of eliminating them were devised. A by-product of the investigation, of great fundamental interest, was the discovery that the peculiar displacements of certain lines in the spectrum of the electric arc, which are greatest near the negative pole, are due to the influence of the electric field. These displacements, previously unsuspected, are sufficient to render such lines wholly unsuitable for use as standards unless rigorous precautions are observed. The international committee, in the light of the new information thus rendered available, will now have no difficulty in completing its task of determining the positions of standard lines with an accuracy formerly unattainable.

The variation of latitude is another subject in which international cooperation has yielded important results. It was found some years ago by astronomical observations that the earth's axis does not maintain a fixed direction in space, but moves in such a way as to cause the earth's pole to describe a small but complicated curve around a mean position. The change in the direction of the axis is so slight, however, that the most accurate observations made simultaneously at different points on the earth, are required to reveal it. These were undertaken at several stations widely distributed in longitude, in Italy, Japan, and the United States. A new photographic method has recently been devised which will probably render unnecessary the use of more than two stations in future work.

An extensive cooperative investigation planned by the Division of Geology and Geography of the National Research Council involves the joint effort of geologists and chemists in the study of sediments and sedimentary deposits. This is of great importance in connection with many aspects of geological history, and also because of its bearing on economic problems, such as the origin and identification of deposits or accumulations of coal, oil, gas, phosphates, sodium nitrate, clay, iron, manganese, etc.

The essential requirements are sufficient information on (1) modern sediments and deposits and (2) changes in sediments after deposition and the causes of such changes.

In the study of sediments now in process of formation it is important to learn the mechanical state and shapes of particles of different sizes, their mineralogical and chemical composition, the arrangement of the material composing the deposit, the source of the material, the transporting agencies, and the cause of precipitation. Modern deposits must be studied in the scores of forms in which they are laid down: in deserts and arid regions and in humid climates, in the beds of great lakes, in the track of glaciers, and in marine beds off the coast, in deltas and bays, or on submarine plateaus, in lagoons, and on reefs in subtropical and tropical waters.

In much of this work chemical investigations are essential, especially on the composition of the waters flowing into the ocean, yielding data on the chemical degradation of the continent and the amount of soluble material discharged into the sea.

In undertaking this extensive investigation, which would include the studies just cited and others on ancient deposits, the following procedure is proposed: (1) To make a more complete survey than has yet been made of the investigations that are at present under way in the United States and Canada. (2) To prepare, in the light of present geological knowledge, a program for the investigations needed to supply an adequate basis for interpreting sediments. As knowledge advances, the program will have to be modified. (3) To canvass the field for existing agencies that are suitable in prosecuting such investigations. (4) To assign problems to those institutions or individuals prepared properly to prosecute researches of the kind needed. (5) To provide additional agencies for the study of problems of sedimentation and thereby make possible investigations for which there are either no provisions or only inadequate provisions at present.

It is easy to see how an investigator choosing to deal with some aspect of this large general problem would be assisted by in-

formation regarding related work planned or in progress, and how readily, as a member of the group, he could render his own researches more widely useful and significant.

Another interesting piece of cooperative research, which involves the joint activities of geographers, physicists, zoologists, and practical fishermen, is centered largely at the Marine Biological Laboratory at La Jolla, California. Systematic measurements of the temperature of the Pacific near the coast show occasional upwelling of cold water. Simultaneous biological studies reveal a change in the distribution of microscopic organisms with the temperature of the water. This has an immediate practical bearing, because the distribution of the organisms is a dominant factor in the distribution of certain food fishes. The source of the temperature changes and their influence on meteorological phenomena, are other interesting aspects of this work.

In the field of engineering, the possibilities of cooperative research are unlimited. The fatigue phenomena of metals have been chosen by the Engineering Division of the National Research Council, acting in conjunction with the Engineering Foundation, as the subject of one of many cooperative investigations. Metals and alloys which are subjected to long-repeated stresses frequently break down, especially in aircraft, where the weight of the parts must be reduced to a minimum. The elastic limit and, to a lesser degree, the ultimate strength of steel can be raised by working it cold, provided that a period of rest ensues after cold-working. The tests indicate, however, that increased static strength due to cold working does not necessarily indicate increased resistance to fatigue under repeated stress. In the case of cold-stretched steel, for low stresses the fatigue strength is actually less than for the same steel before stretching.

These phenomena, and others that illustrate the complexity of this problem, afford abundant opportunity for further research. The membership of the committee includes representatives of educational institutions, the Bureau of Standards, and several large industrial establishments. The work was divided among the members, two dealing with its metallographic features, two with machines for testing, two with mechanics of the materials involved, and one with a survey of the subject from the standpoint of the steel manufacturer. The results already obtained promise much for the future success of this undertaking.

Scores of other illustrations of effective cooperation in research might be given, especially in astronomy, where each of the 32 committees of the International Astronomical Union is constituted for the purpose of organizing cooperative investigations. In spite of the length of this list of committees, it can not be said that astronomy offers any unique possibilities of joint action. The division of the sky among widely separated observers is only a single means of cooperation, which may be paralleled in geology, paleontology, geography, botany, zoology, meteorology, geodesy, terrestrial magnetism and other branches of geophysics, and in many other departments of science. Most of the larger problems of physics and chemistry, though open to study in any laboratory, could be attacked to advantage by cooperating groups. In fact, it may be doubted whether research in any field of science or its applications would not benefit greatly by some form of cooperative attack.

As for the fear of central control, and of interference with personal liberty and individual initiative, which has been entertained by some men of science, it certainly is not warranted by the facts. Cooperative research should always be purely voluntary, and the development of improved methods of observation and novel modes of procedure, not foreseen in preparing the original scheme, should invariably be encouraged. They may occasionally upset some adopted plan of action, but if the cooperating investigators are following the wrong path, or neglecting easily available means of improving their results, the sooner this is discovered the better for all concerned.

Canada and the United States, enjoying similar natural advantages, and lying in such close proximity as to permit the greatest freedom of intercourse, are most favorably situ-

ated to profit by cooperation in research. In both countries national movements for the promotion of research are in progress and important advances are being made. The example set by the Canadian government in establishing the Honorary Advisory Council for Scientific and Industrial Research and that of the Royal Canadian Institute in organizing this series of addresses on research and its applications, have stimulated and encouraged us in the United States. The friendly bonds that have joined the two countries in the past have been greatly strengthened by the war, and I am sure that our men of science will welcome every opportunity to cooperate with yours in common efforts to advance science and research.

GEORGE ELLERY HALE

## GENERAL CHEMISTRY AND ITS RELATION TO THE DISTRIBUTION OF STUDENTS' SUPPLIES IN THE LABORATORY

THE object of the general chemistry laboratory is, I take it, to teach chemistry. Its mechanical aspect is clearly a business on a par with any other undertaking that has a special object in view. True, the methods will differ somewhat from other endeavors, but the main idea of striving "to put across" a definite proposition puts the laboratory side of teaching chemistry on a straight business basis, and subject to the ordinary rules of business. Now a business firm no matter what the character of its work, knows that if they are to compete with others, they must avail themselves of every method, scheme or device that will cheapen production, facilitate transportation, add to the efficiency of their employees, or in any other way make better goods at a lower price than the competing firm. They are ever on the watch for a new idea and many dollars' worth of machinery are often scrapped to give place to a newer and more efficient machine. Many firms employ efficiency experts constantly seeking to improve or save anywhere and everywhere throughout the works. No progressive firm ever stands still, but is ever changing its methods for better ones. This does not seem to be true always in the conducting of a chemical laboratory. What "Bunsen did" many years ago is good enough now, and the old song, "the old time religion is good enough for me" seems to apply very appropriately to the management of many laboratories.

Such a state of affairs should not be, and these laboratories with unchanging methods will go to the wall as surely as will a business house run on similar ideas.

A recent questionnaire sent to a large number of institutions in all parts of this country reveals the fact that general chemistry is regarded as the most important and vital course in the department. The grade of work done in all other courses is determined by the nature of this course. If it is poorly given, all other courses are built on a poor foundation, and a poorly trained chemist is the result. The importance of this course is further brought out by this questionnaire, when we note that the number of laboratory hours in general chemistry varies from six to eight per week, for one year. In some cases this is in addition to a year of physics and chemistry in the high school. This, in many cases means that a student before he can take qualitative analysis in college has had in the high school one year of chemistry of say five hours a week for forty weeks, which makes a total of two hundred hours. In college, he has two laboratory afternoons of three hours each and three or four recitation hours a week for a year of thirty weeks, which amounts to 270 hours as a minimum. In other words, the student has had 200 hours in high school and 200 hours in college, or a total of 470 hours, exclusive of all home study both in high school and college. A few years ago these same institutions gave only five hours a week to general chemistry, but the growth of chemistry in this country has demanded a correspondingly increased preparation of students (on the part of institutions) and a very generous response has been given all over America. This increased preparation has been made possible by putting into the students earlier and basic training the best the institu-

tion had, in quality of instruction, equipment, largely increased laboratory time, and a universal recognition that the important course to the department, as a whole, is general chemistry. It might be said, and some progressive administrators and teachers *do* say, that a chemistry department can be rated in terms of its general chemistry. We can almost say that there is no department of chemistry in this country that can be classed as a great or strong department whose general chemistry is not the best course that the department can secure by having experienced teachers to handle the work, having excellent equipment, modern laboratories, and a sufficient number of laboratory hours to do the work required. Unfortunately some few large institutions still have not changed their general chemistry to meet the new conditions. One has only 4½ hours a week for one year without a year of high school chemistry as a prerequisite; another has had its hours reduced by the board of trustees from five hours a week for a year to four (without a year of high-school chemistry as a prerequisite); this despite the strong protest of the administrative head and the entire teaching staff. This is certainly a mistake, a short-sighted policy, and a backward step by the board. Why should a body of business men who are not experts in this line, determine the policy of a department and neglect the advice of those who do know and have the good of the department at heart?

The greatest confirmatory proof of the statement made that a department of chemistry is great in proportion to the quality of its general chemistry is found by making a list of those institutions, which rank highest in this country from the point of view of research and of the training of its students, and comparing the effort expended in making general chemistry the very best. It will be found that the institutions of the highest rank have a first class course in general chemistry with six hours a week or more in laboratory work for one year. Those who do not take this ever-growing and modern point of view will surely become decadent departments.

The ever-growing importance of chemistry will demand an ever increasing efficiency. I predict that the time is not far distant when an investigation carried on by such an organization as the Carnegie Foundation similar to that done in the medical schools[1] of this country and Canada, will be instituted, and a result similar to that of this report on low grade medical schools, viz., an elimination of those institutions who do not do so good chemistry work. When such a report is published, those low grade institutions will cease to teach chemistry, because the students, knowing the true state of affairs will either not elect chemistry, or if interested, will go elsewhere where the subject is properly taught.

Before taking up the working of the "Freas System"[2] in the general chemistry laboratory, we wish to review briefly the existing methods now in use.

First, the old side-shelf reagent system which is very common, in fact now exists in most college laboratories in this country. Nothing can be said in favor of this system, as it has no virtues, and possesses innumerable evils. It is wasteful, expensive, untidy; almost impossible to prevent contamination of chemicals and is one of the main sources for wasting students' time and encouraging petty theft. In a chemical laboratory of one of the oldest universities in this country, where the side-shelf reagent scheme is used, a student needs one particular chemical five times during the course. For this one chemical alone he has to walk five hundred feet during the term. One hundred and forty chemicals are used, and it can readily be seen that a large amount of time will be wasted if he makes but one trip for each chemical. One trip to the side shelf for these chemicals means a walk of thirteen miles, while a double trip, which is most common, would amount to a twenty-six mile walk or equal to two or more laboratory weeks work. The director of this department told me that while

[1] Published in a report to the Carnegie Foundation on Medical Education in the United States and Canada by Abraham Flexner, Bulletin Number 4, 1910.

[2] Science, May 30, 1919.

taking these laboratory walks to the side shelf the student was deep in chemical thought and therefore it was a good thing. My observation of students in this laboratory and elsewhere leads me to believe that this director seldom enters the chemical laboratory, and therefore does not know the true state of affairs, nevertheless he regards himself eminently qualified to pass on such matters.

One of the most serious objections to this system is not cost, or waste of students' time, but the slovenly habits which a student of a necessity acquires.

In going to a 2-kilogram bottle of potassium iodide, for example, to get 2 grams of that salt the neat and quantitative idea of general chemistry is absolutely lost, although he may be assigned to some general quantitative experiments during the course. Thus, the orderly habits which are so necessary to a good chemist, are not formed when they should be formed, viz., during the early days of his chemical training.

I can not pass without referring to a common sight a few years ago in another large laboratory in this country. Large bottles of chemicals were put on side tables for student use. A cheap porcelain pan balance and a box of weights stood nearby. Suppose a student needs 5 grams of potassium bromide, should it be a bit lumpy, a rusty ring stand served to break up the lumps. A handful of the expensive chemical was then placed on one pan of the scale and the old and corroded 5 gram weight on the other pan. The student brushed the excess chemical from the pan to the floor till he had remaining approximately 5 grams. In the morning I have seen the cleaners sweep up dust pan after dust pan full of valuable chemicals from the floor near this side table. There was seldom any supervision on the part of the instructor in charge when the students were getting their chemicals or conditions would probably not have been so bad. This institution of course was not famous for turning out great chemists and a sudden change in administration alone would save its life. To-day this same laboratory is one of the most up-to-date and progressive laboratories in this country. Few of the former teaching staff now remain, as they were too firmly fixed in the old ways to make reform possible.

The next step in the evolution of the handling of students' chemicals and supplies was to give him a kit of apparatus and place on his bench in the laboratory all the chemicals needed for the day or week. If two men worked on opposite sides of a bench this one set was sufficient for them both, *e. g.*, in a laboratory which holds 28 students at a time 14 such kits are used. This was a very great advance over the side-shelf reagent plan, as it eliminated a great deal of walking on the part of the student, thus enabling him to do much more work. One institution made this change and at the same time enormously increased the amount of assigned laboratory work per afternoon. While this scheme is a great improvement, it has still serious drawbacks. Chemicals are still bound to be mixed up and contaminated no matter how watchful the instructor may be. Certain chemicals are always running short, as some student will take more than his share even though a cheap balance is provided for every two men, so that weighing out approximate amounts is an easy and rapid matter.

Theft of chemicals is still possible, as no instructor can watch 25 students all at one time, and even if he could do so, he can not determine whether chemicals placed in a test tube were for laboratory or home use; this method while cheaper than the first is still expensive, because the students are bound to waste chemicals when they are handy and do not cost them anything; the bottles are always getting mixed up and out of place; and finally it entails enormous amount of work on the stock system or for the instructor, out of laboratory hours, as well as a certain amount of the same kind of stock work during the laboratory period.

In one institution[3] where this plan has been in operation for the past five years a special

[3] Professor C. D. Carpenter's laboratory at Teachers' College, Columbia University.

staff of women is employed to make up sets of common chemicals, place them on the students' desks and on completion of this set of experiments, refill the bottles and place them away for the next time needed. One equipping a week generally suffices for a laboratory with several fillings of certain bottles. This plan relieves the instructor of stock duties, but is still open to the objections named above.

In another large institution with nearly 1,000 students in general chemistry, the change was made from the side-shelf plan to the method of supplying a student chemicals at his bench. Here again the amount of laboratory work was nearly doubled per afternoon, because of the more efficient handling of supplies and a corresponding saving of students' time. Unfortunately in this institution no provision was made for the putting up of sets of chemicals by the stock division and the entire teaching staff in this division became stock keepers and more energy was expended in filling bottles than in giving instruction. This overload was at once observed in a decreased efficiency of work on the part of the instructor, and strenuous appeals have been made to the administrative head to relieve a most intolerable condition. Much cheaper and less highly trained people can and should be secured to fill bottles and do this kind of work, and a director of a chemistry department is short-sighted indeed who insists on his teaching staff spending most of their time doing the work of a ten-dollar-a-week boy. It can be clearly seen that the efforts to improve the work in general chemistry in this particular institution are not appreciated, or conditions will be improved at once and the teacher given a chance to perfect himself in his chosen profession and give the students the benefit of his experience. The failure of an executive to encourage and aid progressive teachers in the development of new ideas along this line is not only a very great injury to the teacher concerned, and to the institution as well, but is professional suicide to the administrator himself. It has been shown that the second scheme is an improvement over the first, but is still open to objections, and while it possesses considerable merit, it has many fatal defects.

The third plan, viz., the Freas System in the general chemistry laboratory has all the virtues of the second plan and none of its defects. In fact, when this plan is properly installed and carried out, it leaves little to be desired for both student and instructor.

The plan in brief is to give the student on his first day all the apparatus and chemicals he will need for that course. The student after the payment of all fees and deposits reports to his instructor and is assigned in writing to a bench in the laboratory. He takes this assignment to the stock room and receives his apparatus and chemicals in heavy cardboard or metal boxes and takes them to his bench. This kit he arranges in his desk as stated in his directions If he has properly arranged his material he can quickly find any special chemical or piece of apparatus and is ready for work within two hours of starting. He puts his own padlock on his bench and he alone is responsible for its contents till his course is completed at the end of the term. He has received just enough of each chemical to perform the experiment plus a slight excess to offset any possible unavoid able accident. Should he be careless and not perform his experiment properly he must go to the store room and sign for more chemicals which of course are charged to his account, and later deducted from his advance breakage and "excess chemicals" deposit. Right here it should be stated for clearness that the student is charged for all apparatus and chemicals, but is given as a free allowance the average value of the chemicals used by his class. If he has a modern bench, with a hod in front of him, all walking about has been eliminated, and the amount of laboratory work that he can do per afternoon can be nearly tripled over that possible under the side-shelf reagent scheme.

Contamination of chemicals is impossible under this plan, as each container is plainly labelled and is under the personal care of the student interested.

The factor of expense has been reduced to the minimum, as there can be no waste from

the department's point of view and the student has received as a free allowance, sufficient chemicals for his needs, providing he is the average student and exercises moderate care. The possibility of theft is withdrawn absolutely, as the kit belongs to the student, to do with as he wishes, and no student will or can steal his own things. The prices on his list are selected from the most recent catalogue of the largest apparatus house in his vicinity, so he has no temptation to take things home because he saves by so doing. In fact in many cases an apparatus house will sell him things somewhat cheaper. Theoretically the student can if he wishes get all his kit elsewhere, and this is encouraged, as it will save the department the trouble of furnishing it, but the student would much rather take the department kit which is all ready made up and easy to procure, and is just exactly what he needs in his course.

This system takes out of the hands of the teaching staff all cares in regard to apparatus and chemicals, as this side of the work is handled by a trained body of men and women who soon learn to do the bottling of chemicals and the assembling of the same into kits, with the greatest speed and accuracy. In rush times, student help makes possible the doing of a great deal of work in a short time and is a benefit to both the department and the student.

The Freas System is just as helpful and as easily installed in a high school as in a technical school, college or university laboratory.

Of course each student must have the average size bench, viz., about 8,000 cubic inches, in order to hold this kit. Many laboratories give the student more space than this, but if one takes the measurement of a student bench in high schools and colleges all over this country, the figure 8,000 cubic inches is about the average. Unfortunately in a few good institutions circumstances over which the departmental authorities had no control, forced a reduction of students' bench space. More students were crowded into the laboratories than the benches were able to accommodate, and it seemed at that time wise to begin to reduce the size of the student bench. In one case this went on until a student finally had but one drawer of about 400 cubic inches. In such a space only the most meager equipment can be placed, and the student of course suffers through lack of apparatus and an enforced walking to the storeroom and back for every little thing he may need. The pendulum has started to swing back, and I have no doubt that before long this department will restore the normal 8,000 cubic inches.

Some may say that the cost of installing this system is prohibitive. This is not so, as can be shown by actual figures in institutions using it. Others may wish to know where this scheme has been tried out for a sufficient length of time as to insure it being out of the experimental stage. The department of chemistry of Columbia University in New York City has been using this system for the past eight years with an ever-increasing satisfaction to all concerned, in all divisions of the department.

There is no question but that the Freas System is the cheapest, everything considered, most efficient, and up-to-date method of handling students' supplies yet devised. If a chemical department wishes quality of work above everything else, then this system will be an enormous aid to both student and instructor; but if quantity is the object to be obtained, then it does not matter so much, as quality of work is probably given but little thought. If a department must handle large numbers of students and wishes quality of work as well, then there is no question but that the quicker the authorities investigate the Freas System the better. No unprejudiced man can see this system in operation without feeling that he will not be satisfied till it is as speedily as possible installed in his own department.

W. L. ESTABROOKE

DEPARTMENT OF CHEMISTRY,
COLLEGE OF THE CITY OF NEW YORK

## HERBERT SPENCER WOODS

HERBERT SPENCER WOODS, assistant professor in the department of physiology, pharmacol-

ogy and biochemistry, died on January 4, 1920, in Dallas, Texas, following an operation.

Professor Woods was born and raised a Missourian and descended from Virginia and Kentucky stock.

He received the A.B. and A.M. degrees from the University of Missouri. While pursuing work for the Master's degree he came under the influence of the late Waldemar Koch with whom he conducted fundamental research on the distribution of the lecithins.

Later work and study were had at the Universities of Illinois, Wisconsin, and California and at the Ohio Agricultural Experiment Station. His earliest teaching experiences were enjoyed at the Universities of Illinois and Wisconsin and later on in a high school of California.

Professor Woods's first teaching in Texas was at the Texas Christian University, at Fort Worth, and a little later at the Grubbs Vocational College, an institution connected with the Agricultural and Mechanical College of Texas.

Those who gained an intimate acquaintance with Professor Woods found him to be a man possessed of extraordinary ability. His habits were simple and abstemious, his temperament sensitive and impetuous, very often not sanguine and serene enough for steady happiness.

As a man of science he was essentially clean, candid and a devout lover and seeker of the truth.

When he died he was thirty-six years of age, a period in life when most begin to live in enjoyment of the progression of science. He was a fellow of the American Association for the Advancement of Science.

Lewis William Fetzer

## SCIENTIFIC EVENTS

### THE LISTER MEMORIAL INSTITUTE IN EDINBURGH

As has been noted in Science, the project originated before the war, for the establishment in Edinburgh of a permanent memorial to the late Lord Lister, has been revived. The *British Medical Journal* states that the University of Edinburgh, the Royal College of Physicians and the Royal College of Surgeons of Edinburgh have come to the conclusion that the most suitable form for such a memorial will be an institute in which the scientific investigation of disease in any of its forms can be undertaken, and in which the principal sciences concerned can be adequately taught. It was in Edinburgh that Lister elaborated and consolidated his system, and it is appropriate that the scientific spirit which animated him and the methods of research he developed should be commemorated and continued in that city. Lister's work in the wards of the Royal Infirmary would have been fruitless—could not indeed have been carried out—had he not first tested his theories in the laboratory. It was in and through research that his system of treatment came to fruition. Research was the keynote of his work, and it is to research and the teaching of the results of research that the proposed memorial is to be dedicated. The need for such a centralized teaching and research institute in Edinburgh, it is said, is pressing. At the present time the burden of such work is borne by the university department of pathology and the laboratory of the Royal College of Physicians. Of these, the former, built and equipped thirty-five years ago, is now inadequate, and the resources of the latter, particularly as regards the accommodation of the workers, are entirely insufficient, even for present needs. There is as yet no permanent memorial to Lister in Edinburgh, and it is felt that the rapid development of pathology, of bacteriology, of clinical pathology, of pathological chemistry, and of other cognate branches of knowledge has widened the field to such an extent as to render it necessary that the building erected to his memory shall be modern in design and equipment, and sufficiently large to house all the departments enumerated. The proposed new institute will be managed by a board on which the university and the two Royal Colleges will be represented.

A committee has been formed to make an appeal for £250,000 to pay for the site, to erect

and equip the necessary buildings, and to provide for maintenance, apart from remuneration to research workers. A site, described as extensive and extremely suitable, has been secured close to the Edinburgh Royal Infirmary and the medical school of the university at a cost of over £50,000. The president of the committee is the Right Hon. A. J. Balfour, M.P., chancellor of the university, and vice-presidents are the Duke of Atholl, the Earl of Rosebery, Earl Beatty, Lord Glenconner, Lord Leverhulme, and Sir J. Lorne MacLeod. An appeal has been issued, signed by Sir J. A. Ewing, principal of the university, Sir R. W. Philip, president of the Royal College of Physicians of Edinburgh, and George Mackay, president of the Royal College of Surgeons of Edinburgh. The university has given £10,000, the college of physicians £10,000, and the college of surgeons £5,000.

### A JOURNAL OF ECOLOGY

COOPERATION in science doubles the value of each man's knowledge and efforts. The Ecological Society of America, comprising zoologists, botanists, foresters, agricultural investigators, climatologists and geographers, is a link in the cooperative chain which will bind the natural sciences together. The society has long felt the need of having its own journal, and at its St. Louis meeting last December voted to start a serial publication to present original papers of an ecological character.

The enterprise is made possible by the generous action of the owners of *Plant World*, who are giving this magazine to the Ecological Society to continue as its official organ. The new serial will begin as an illustrated quarterly of about 200 to 300 pages per year, known as *Ecology*. The Brooklyn Botanic Garden is undertaking the publication of this journal in cooperation with the Ecological Society under an agreement substantially like that under which the *American Journal of Botany* is now being published. The *Plant World* will complete the present volume, number 22, and *Ecology* will begin with the number for March, 1920. Barrington Moore, now serving his second term as president of the Ecological Society, has been elected editor-in-chief.

### PUBLIC LECTURES OF THE CALIFORNIA ACADEMY OF SCIENCES

THE California Academy of Sciences, under the direction of Dr. Barton Warren Evermann, maintains a Sunday afternoon lecture course devoted to popular science topics in its Museum in Golden Gate Park. This course is steadily gaining in popularity and serves a useful purpose in bringing into closer relations the research man and the public. The lecturers are largely drawn from the research departments of the University of California and Stanford University. Following is the schedule for February and March:

February 1. "The ocean as an abode of life." Dr. W. K. Fisher, director of the Hopkins Marine Station of Stanford University.

February 7. "Life of the deep sea." J. O. Snyder, associate professor of zoology, Stanford University. Illustrated.

February 15. "The ocean meadows, or the microscopic life of the open sea." Dr. C. A. Kofoid, professor of zoology, University of California. Illustrated.

February 22. "Fishes of the California coast." E. C. Starks, assistant professor of zoology, Stanford University. Illustrated.

February 29. "Marine mammals." Dr. Harold Heath, professor of zoology, Stanford University. Illustrated.

March 7. "The fur seals of the Pribilof Islands." Dr. Barton Warren Evermann, director of the Museum, California Academy of Sciences. Illustrated.

March 14. "Life between tides." Dr. W. K. Fisher, director of the Hopkins Marine Station of Stanford University. Illustrated.

March 21. "Oceans of the Past." Dr. J. P. Smith, professor of paleontology, Stanford University.

March 28. "Systematic and economic phases of California marine algæ." Dr. N. L. Gardner, assistant professor of botany, University of California.

### DEATHS FROM INFLUENZA AND PNEUMONIA

THE Bureau of the Census has issued a bulletin containing records of deaths in larger cities from influenza and pneumonia which are as follows:

| | Influenza, Week Ending January | | | | | Pneumonia, Week Ending January | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 10 | 17 | 24 | 31 | 3 | 10 | 17 | 24 | 31 |
| Albany | 2 | 1 | 0 | 0 | 3 | 4 | 2 | 2 | 3 | 11 |
| Atlanta | | | | | 1 | 6 | 17 | 10 | 10 | |
| Baltimore | 1 | 0 | 1 | 0 | 14 | 29 | 20 | 34 | 24 | 45 |
| Birmingham | 2 | | | 2 | 4 | 9 | 11 | 8 | 14 | 10 |
| Boston | 0 | 1 | 0 | 2 | 25 | 24 | 27 | 28 | 43 | |
| Buffalo | 0 | 0 | 0 | 2 | 8 | 13 | 10 | 7 | 17 | 9 |
| Cambridge | 0 | 0 | 0 | 0 | 2 | 4 | 8 | 7 | 8 | 12 |
| Chicago | 6 | 13 | 21 | 200 | 586 | 92 | 94 | 132 | 272 | 523 |
| Cincinnati | 3 | 2 | 1 | 1 | 1 | 15 | 12 | 11 | 16 | 24 |
| Cleveland | 2 | 2 | 1 | 4 | 16 | 26 | 19 | 24 | 22 | 25 |
| Columbus | 0 | 3 | 0 | 2 | 5 | 5 | 12 | 9 | 6 | 17 |
| Dayton | 0 | 0 | 0 | 5 | 10 | 7 | 4 | 7 | 8 | |
| Denver | 0 | 1 | 0 | 1 | 19 | 15 | 20 | 18 | 23 | |
| Fall River | 1 | 0 | 0 | 0 | 0 | 2 | 7 | 10 | 5 | 3 |
| Grand Rapids | 0 | 0 | 0 | 0 | | 3 | 1 | 4 | 2 | |
| Indianapolis | | 2 | | 1 | | 3 | 16 | 16 | 20 | |
| Jersey City | 0 | 0 | 2 | 5 | | 12 | 14 | 12 | 19 | |
| Kansas City | 0 | 0 | 2 | 45 | 73 | 12 | 13 | 27 | 51 | 47 |
| Los Angeles | 0 | 1 | 0 | 1 | 8 | 18 | 15 | 18 | 18 | |
| Louisville | 0 | 0 | 0 | 0 | 2 | 9 | 10 | 10 | 9 | 16 |
| Lowell | 0 | 0 | 0 | 0 | 1 | 3 | 5 | 4 | 2 | 6 |
| Memphis | 1 | 0 | 1 | 0 | 1 | 14 | 12 | 11 | 11 | 9 |
| Milwaukee | 1 | 1 | | 11 | 27 | 14 | 24 | 13 | 34 | 114 |
| Minneapolis | 1 | 2 | 3 | 2 | 46 | 19 | 10 | 7 | 7 | |
| Nashville | 0 | 0 | 3 | 2 | 2 | 4 | 6 | 8 | 4 | 10 |
| Newark | 0 | 3 | 0 | 4 | 14 | 15 | 14 | 14 | 26 | 41 |
| New Haven | 1 | 0 | 0 | 1 | 8 | 10 | 6 | 8 | 9 | |
| New Orleans | 5 | 3 | 0 | 4 | 9 | 13 | 24 | 27 | 23 | |
| New York | 6 | 13 | 13 | 108 | 557 | 189 | 205 | 248 | 403 | 751 |
| Oakland | 0 | 0 | 2 | 3 | 12 | 7 | 4 | 6 | 17 | |
| Omaha | 0 | 0 | 1 | 1 | 12 | 5 | 4 | 6 | 12 | |
| Philadelphia | 2 | 2 | 5 | 3 | 16 | 62 | 53 | 70 | 105 | 137 |
| Pittsburgh | 1 | 0 | 2 | 5 | 11 | 54 | 47 | 51 | 50 | 65 |
| Portland, Oregon | | | | | | 4 | 13 | 8 | 9 | |
| Providence | 1 | 0 | 0 | 1 | 2 | 5 | 12 | 13 | 7 | 12 |
| Richmond | 0 | 0 | 1 | 0 | 8 | 6 | 2 | 8 | 6 | 13 |
| Rochester | 0 | 0 | 0 | 1 | 9 | 8 | 13 | 7 | 11 | 14 |
| St. Louis | 2 | 2 | 0 | 6 | 77 | 45 | 55 | 41 | 67 | 159 |
| St. Paul | 0 | 0 | | 12 | 52 | 7 | 4 | | 14 | |
| San Francisco | 1 | 1 | 6 | 15 | 27 | 19 | 13 | 20 | 33 | 32 |
| Seattle | 2 | | 0 | 1 | 0 | 7 | 2 | 4 | 6 | 12 |
| Spokane | 0 | 0 | 1 | 0 | 1 | 0 | 4 | 2 | 3 | |
| Syracuse | 0 | 0 | 0 | 1 | 8 | 6 | 9 | 8 | 9 | 23 |
| Toledo | 0 | 1 | 0 | 2 | 7 | 8 | 8 | 8 | 7 | 11 |
| Washington, D.C. | 1 | 0 | 2 | 28 | 77 | 31 | 22 | 25 | 53 | 104 |
| Worcester | 0 | 0 | 0 | 0 | 4 | 5 | 10 | 9 | 7 | 10 |
| Total | 42 | 54 | 68 | 482 | 1,765 | 868 | 913 | 1,020 | 1,525 | 2,265 |

### GIFTS TO THE NATIONAL RESEARCH COUNCIL

THE last issue of the *Proceedings* of the National Academy of Sciences prints the minutes of a joint meeting of the executive board of the National Research Council with the council of the National Academy of Sciences on June 24, 1919, which records gifts for the support of the council from the Carnegie Corporation and the Rockefeller Foundation.

The president of the National Academy of Sciences presented the following resolution which was passed by the Carnegie Corporation of New York on June 3, 1919, making provision to cover expenses of the National Research Council during the coming year:

*Resolved,* that, pursuant to paragraph 3 of the resolution recording action taken at the special meeting of the board of trustees held March 28, 1919, the sum of one hundred thousand dollars ($100,000) be and it hereby is appropriated to the National Academy of Sciences for the use of the National Research Council for the year beginning July 1, 1919; and that the treasurer be and he hereby is authorized to make payments as needed to the extent of $100,000 on certificates of the chairman of the National Academy of Sciences and the chairman of the National Research Council.

*Moved:* That the executive board of the National Research Council go on record as appreciating the recognition by the Carnegie Corporation of New York of the work which it is accomplishing by appropriating the sum of $100,000 for its use for the year beginning July 1, 1919.

The chairman of the National Research Council presented the following letter from the Rockefeller Foundation, appropriating the sum of $20,000 to meet the expenses involved in conferences of special subcommittees on research subjects of the Division of Physical Sciences.

THE ROCKEFELLER FOUNDATION

June 20, 1919

*My Dear Mr. Merriam:* I have the honor to inform you that at a meeting of the executive committee of the Rockefeller Foundation held June 16, 1919, the following resolution was adopted:

*Resolved:* That the sum of twenty thousand dollars ($20,000) be, and it is hereby, appropriated to the National Research Council for the Division of Physical Sciences, of which so much as may be necessary shall be used to defray the necessary travelling and other expenses involved in conferences of the subcommittees of that division during the year 1919.

Very truly yours,
EDWIN R. EMBREE,
*Secretary*

*Moved:* That the chairman of the National Research Council express in behalf of the executive board its appreciation of the interest which the Rockefeller Foundation has shown in the research work of the Division of Physical Sciences by appropriating the sum of $20,000 to meet the expenses involved in conferences of special subcommittees on research subjects of that division.

## SCIENTIFIC NOTES AND NEWS

OFFICERS of the Geological Society of America were elected at the Boston meeting, as follows: *President,* I. C. White, Morgantown, W. Va. *First Vice-president,* George P. Merrill, Washington, D. C. *Second Vice-president,* Willet G. Miller, Toronto, Canada. *Third Vice-president,* F. B. Loomis, Amherst, Mass. *Secretary,* Edward B. Mathews, Baltimore, Md. *Editor,* Joseph Stanley-Brown, New York, N. Y. *Councilors,* H. E. Gregory, New Haven, Conn.; R. A. Daly, Cambridge, Mass.; William S. Bayley, Urbana, Ill.; E. W. Shaw, Washington, D. C.; T. W. Vaughan, Washington, D. C.; George F. Kay, Iowa City, Iowa. *Past Presidents,* Frank D. Adams, Whitman Cross and John C. Merriam, are likewise *ex officio* on the council.

PROFESSOR LAFAYETTE B. MENDEL, of Yale University, has been elected an associate member of the Société Royale des Sciences Médicales et Naturelles of Brussels.

DR. R. BENNETT BEAN has been elected a corresponding member of the Anthropological Society of Rome.

PROFESSOR ARTHUR STANLEY EDDINGTON, of the University of Cambridge, has received the G. de Pontécoulant prize of the Paris Academy of Sciences for his studies of stellar motions.

PROFESSOR H. G. GREENISH, dean of the Pharmaceutical Society School of Pharmacy, London, has received the honorary doctorate from the University of Paris.

DR. HANZ GERTZ, of the physiological laboratory of Karolina Institute, Stockholm, has been awarded the Jubilee Prize by the Swedish Medical Association for his work on the functions of the labyrinth.

MR. T. W. READER has been selected by the British Geologists' Association as the first recipient of the Foulerton award. The sum of money which has enabled the association to make this award is the recent gift of Miss Foulerton in accordance with the wishes of her late uncle, Dr. John Foulerton, who was for many years secretary to the association.

Mr. R. M. Davis resigned from the Power Section of the Water Resources Branch, U. S. Geological Survey, in October, to take up work as statistician for the *Electrical World*. He takes the position of Mr. W. B. Heroy, formerly of the survey, who has entered the employ of the Sinclair Oil Corporation.

Professor W. S. Brown, who has been acting as chief of the division of horticulture of the Oregon Agricultural College since Professor C. I. Lewis resigned to become manager of the Oregon Fruit Growers' Association, has been appointed permanent chief.

Since the return of Mr. Eugene Stebinger from private work in the Tampico oil field of Mexico he has been appointed chief of the foreign section of the Mineral Resource Branch, U. S. Geological Survey.

Dr. Frank Schlesinger, director of the Allegheny Observatory, lectured on "The Einstein Theory of Relativity from the Point of View of an Astronomer" at the Carnegie Institute of Pittsburgh on January 27. The lecture was followed by a general discussion of the subject.

The death is announced of Dr. Christian R. Holmes, dean of the college of medicine, University of Cincinnati. It was largely through his energy and enthusiasm that the General Hospital with its fine equipment was built and the College of Medicine organized. By the terms of his will Dr. Holmes gave $25,000 to establish a medical journal. A memorial fund will be collected by popular subscription in order to establish a department of research in medicine.

Dr. David S. Pratt, who since the beginning of the year has been a practising chemist at St. Louis, has died at the age of thirty-four years. He had taught in the University of Pittsburgh and later had become an assistant director of the Mellon Institute of Industrial Research. He had received his doctor's degree from Cornell University.

Dr. E. R. Hoskins, assistant professor of anatomy in the University of Minnesota, died on January 30 after a brief illness with influenza and pneumonia.

The death is announced of Professor Severin Jolin, incumbent of the chair of chemistry and pharmacology at Stockholm and at Upsala. To him is ascribed in large part the high standard of the Swedish Pharmacopeia as he has taken an active share in the revision of the different editions. He had recently been elected president of the Swedish Medical Association.

The *Bulletin* of the American Mathematical Society records the deaths of the following German mathematicians: Professor E. Böttcher, of the University of Leipzig, at the age of seventy-two years; Professor O. Dziobek, of the Charlottenburg Technical School, at the age of sixty-three years; Professor F. Graefe, of the Charlottenburg Technical School, at the age of sixty-three years; Professor E. Netto, of the University of Giessen, at the age of seventy-two years; Dr. K. T. Reye, formerly professor at the University of Strassburg, at the age of eighty-one years; Professor R. Sturm, of the University of Breslau, at the age of seventy-seven years, and Dr. J. Wellstein, formerly professor at the University of Strassburg, in his fiftieth year.

The annual meeting of the Society of American Foresters was held in New York City on January 14, 1920. The meeting was given up to the consideration of papers on technical forestry presented by members, and reports of special committees and the officers for the past year.

On October 3, 4, 5 and 6 there was held at Batavia, Java, the first Dutch East Indies Scientific Congress with two hundred and seventy members in attendance. Papers were read before mathematical, biological, medical and geological sections and at the General Session it was decided to continue the association and to hold the next meeting in 1921. The congress concluded with a two-days' excursion to the island-volcano Krakatau to study the renewing vegetation and geological formations.

The eighth annual meeting of the American Association of Variable Star Observers, which

was held at Harvard College Observatory on November 8, was attended by about fifty members and friends. Mr. Leon Campbell was elected president for the year and Professor Anne Young, of Mount Holyoke, was elected vice-president. The program of the meeting consisted of papers and reports, followed by a banquet at which Rev. Joel Metcalf was the guest of honor. This association is composed of amateur astronomers who are anxious to contribute observations of value, and over a hundred thousand observations have been published. It offers an opportunity for all lovers of astronomy to do work of value; particularly those who have small telescopes stored away and do not know how to put them to use. Any one interested should write to Mr. William T. Olcott, secretary, 62 Church Street, Norwich, Conn.

The University of Illinois has recently added to its collections a historical herbarium of about 3,000 specimens formed early in the last century by Dr. Jonathan Roberts (1805–1878). Dr. Paddock, after holding a professorship in the literary department of the college became a professor in Worthington Medical College, at Worthington, Ohio, when Dr. J. L. Riddell, well known as a botanist in his day, moved from that institution to the University of Louisiana. He is said to have been a scholarly man, and an ardent botanist, who enjoyed particularly the friendship of Sullivant, the banker-bryologist of Columbus.

A meeting was held in New York City on December 3 to commemorate the eightieth anniversary of the beginning of Captain John Ericsson's work in this country, and the thirtieth anniversary of the death of Captain Ericsson and of Mr. Cornelius H. DeLamater, founder of the DeLamater Iron Works, where Captain Ericsson's most important work was executed. The exercises included addresses by Hon. Lewis Nixon, commissioner of public works, Borough of Manhattan; Rear-Admiral Bradley A. Fiske and Hon. W. A. Ekengren, Sweden's Minister at Washington. Mr. H. F. J. Porter gave an illustrated historical review of the work performed at the Phœnix Foundry and the DeLameter Iron Works.

## UNIVERSITY AND EDUCATIONAL NEWS

Mr. Charles H. Swift, of Chicago, has given $5,000 to the University of Chicago for its department of geography, for the purpose of sending a member of its staff to Asia the coming autumn. Assistant Professor Wellington D. Jones is to make the trip. He will carry on geographic studies either in China or in India, the choice being determined by conditions in Asia when the trip is made. This will be the second trip of Professor Jones to Asia made possible by Mr. Swift's generosity.

Boston University has concluded an arrangement for an exchange of professorships in mathematics for the college year 1920–21 with Tsing Hua College, Peking, China. Professor Robert E. Bruce, chairman of the department in Boston University, will exchange with Professor Albert H. Heinz, of Tsing Hua. Professor Heinz, head of the department of mathematics, is a graduate of the University of Missouri and has been at Tsing Hua nine years. This college is under the control of the Chinese government and was founded with part of the returned Boxer Indemnity. Professor Bruce will sail from the Pacific coast in April. Professor Heinz will reach this country in time to begin his work at Boston University at the opening of the college in September.

In recognition of the gift of £34,500 by Sir Ralph Forster, Bt., to the fund for the chemistry building and equipment at University College, London, the organic department of the chemical laboratories will be known by his name.

At the University of California, Assistant Professor B. M. Woods has been promoted to a full professorship of aerodynamics.

Dr. Carroll W. Dodge has succeeded Professor Harlan H. York, as head of the department of botany at Brown University and

Walter H. Snell, formerly of the Office of Investigations in Forest Pathology of the Department of Agriculture, has accepted an instructorship in the same department.

Professor A. K. Peitersen, who for the past seven years has been assistant professor of botany and assistant botanist of the experiment station, of the University of Vermont, has gone to Fort Collins, Colorado, where he has been elected professor of botany.

Professor Swale Vincent, who has occupied the chair of physiology at the University of Manitoba (Winnipeg) since 1904, has been appointed professor of physiology in the University of London (Middlesex Hospital). He will probably take up his duties in London at the beginning of May.

Dr. Harold Pringle, lecturer on histology and assistant in physiology in the University of Edinburgh, has been appointed professor of physiology in Trinity College, Dublin, succeeding the late Sir Henry Thompson.

## DISCUSSION AND CORRESPONDENCE

### FURTHER HISTORY OF THE CALCULUS

To the Editor of Science: Please make a correction of my college address to Rose Polytechnic Institute, in the paper on "The Early History of Calculus," in Science for July 11. The error is due perhaps to the fact that only my name was signed to the article.

The quotation from the "Encyclopedia Britannica" should be stated as from the ninth edition, since it has been omitted in the eleventh. The historical part of the article "Inf. Cal." is entirely changed in the last edition to one of still stronger German bias. It makes the statement, for example, that Leibniz did not meet Collins, nor see the tract "De analysi per aequationen . . ." on his first visit to London in 1673. No verification of this statement is offered. English histories and documents have it the other way with regard to Collins.

Evidence of the possible duplicity of Collins which indicates that he was an agent under Oldenberg as early as 1669, appears in the rewritten history. To quote:

> The tract "De analysi per aequationen . . ." was sent by Newton to Barrow, who sent it to John Collins with a request that it might be made known. One way of making it known would have been to print it in the *Philosophical Transactions* of the Royal Society, but this course was not adopted. Collins made a copy of the tract and sent it to Lord Brouncker, but neither of them brought it before the Royal Society. . . . In 1680 Collins sought the assistance of the Royal Society for the publication of the tract and this was granted in 1682, yet it remained unpublished. The reason is unknown. . . .

The usual history is that Collins was the active agent in soliciting the tract "to make it known." Also, Oldenberg was secretary of the Royal Society, and published the *Transactions* for his private profit, without supervision from the society. The relations of these two men were intimate. The tract was probably brought directly to Oldenberg—he has shown that he had knowledge of it—and that he did not act upon it in his official capacity is evidence of conspiracy to suppress it. When both were urging Newton, as already cited, to undertake "for the honor of England," a correspondence which Leibnitz had planned, it was at that time within their power to promote greater honor to England by publishing the tract in the *Transactions*. In reference to the threatened publication in 1680, the death of Oldenberg about two years before, had left Collins without his principal, if Oldenberg were such, and that transaction might have been a shrewd move on Collins' part to retain his honorariums through Leibniz. At least some cause delayed Leibniz seven years in the publication of his calculus, already prepared, while it was put in in the hands of the printer *immediately* after the death of Collins.

There is reason to believe that Leibniz had information of matters transpiring in England before he left Germany. It is difficult to explain otherwise the grandiloquent announcement of wonderful discoveries of new methods in mathematics, which heralded his visit to Paris in 1672, with no work to show, and with admittedly inferior mathematical knowledge for such work. The London exposure by

Pell, in 1673, is clarifying. Leibniz was a politician, not a mathematician, and worked and wrote for the power and prestige of Germany. To this end he founded the Berlin Academy of Science, and was perhaps the first to inaugurate that system of espionage on scientific work in foreign countries by which the usefulness and credit of as much of that work as possible might be transferred to Germany.

It may be urged that calculus has been benefited by the interference of Leibniz. This is true as to notation, but it has been harmful as to the theory and understanding of the subject. On the one hand we have an illogical infinitesimal method, on the other an incomplete derivative one in protest of the first, whose rival expounders reason along different lines, and hardly understand each other. Newton substitutes one rigorous theory, broader than either of these, neglecting no quantity, however small, leaving no unexplained symbol, and yet of an arithmetical character of the utmost simplicity. A free translation of his definition in "Quadrature of Curves," is as follows:

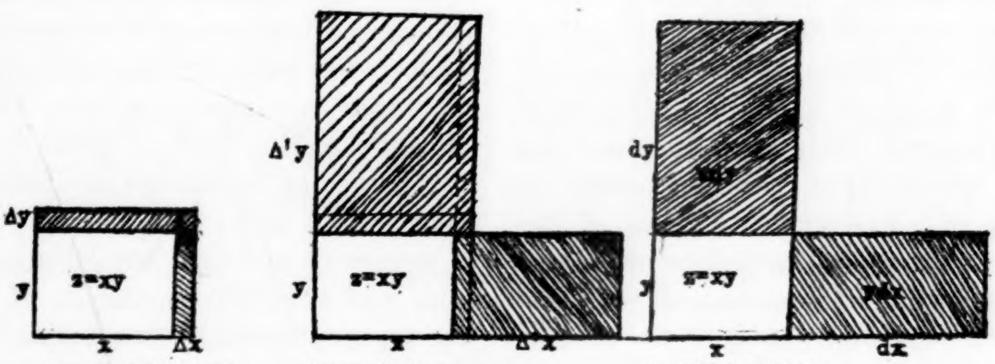
In their highest possible *approximation,* fluxions are quantities in the same ratio as the *smallest possible* corresponding increments of variables, or, in a form of exact statement, they are in the *first* ratio of nascent increments.

Thus fluxions, or differentials, are interpreted as ordinary arithmetical increments, but in a variation defined as *in the first ratio,* or, *as the variables begin to increase,* or, *in the instantaneous state,* which are all one. Starting from given corresponding values, $x$, $y$, $z$, the actual variables are corresponding increments to these with a common *first* value, 0; and starting with any corresponding increments, $\Delta x$, $\Delta y$, $\Delta z$, we form an *ideal* variation *in the same ratio,* $\Delta' x = N\Delta x$, $\Delta' y = N\Delta y$, $\Delta' z = N\Delta z$, where the common multiplier $N$, varies. This is the familiar law of uniform variation between two sets of values of the variables, and the symbols $\Delta' x$, etc., are not limited to small values but vary from 0 to $\infty$, as $N$ so varies, however small $\Delta x$, etc., may be.

Such $\Delta' x$, $\Delta' y$, $\Delta' z$ are approximate fluxions; and the exact fluxions $dx$, $dy$, $dz$, are limits of these for lim. $\Delta x = 0$, lim. $\Delta y = 0$, lim. $\Delta z = 0$. For example, let $z = xy$, then $\Delta z = y\Delta x + (x + \Delta x)\Delta y$, and multiply both members by $N$.

$$\Delta' z = y\Delta' x + (x + \Delta x)\Delta' y,$$

whence by limits, $dz = ydx + xdy$.




Δz=shaded area. Δ'z=shaded area. dz=shaded area.

We may illustrate the three variations geometrically:
(1) Actual. (2) In the Same Ratio. (3) In the First Ratio.

ARTHUR S. HATHAWAY
ROSE POLYTECHNIC INSTITUTE

## SCIENTIFIC BOOKS

### REPORT OF THE CANADIAN ARCTIC EXPEDITION, 1913-18

SHORTLY after the return of the Southern Party of the Canadian Arctic Expedition with their collections in the fall of 1916, steps were taken to arrange for the publication of the scientific results of the expedition. Although the general direction of the operations of the expedition had been under the Department of the Naval Service, most of the scientific men on the expedition were under the Geological Survey, of the Department of Mines, the col-

lections were destined for the Victoria Memorial Museum, of Ottawa, and interdepartmental cooperation was desirable in publishing the results. An Arctic Biological Committee was appointed jointly by the two services, to select specialists to report on the various groups of specimens represented in the collections of the expedition, to distribute the specimens, and arrange for the final publication of the reports. This committee consisted of: Chairman, Professor E. E. Prince, commissioner of Dominion Fisheries; secretary, Mr. James M. Macoun, C.M.G., botanist and chief of the biological division of the Geological Survey; Professor A. B. Macallum, chairman of the Commission for Scientific and Industrial Research; Dr. C. Gordon Hewitt, Dominion Entomologist, of the Department of Agriculture, and Dr. R. M. Anderson, zoologist of the Geological Survey and lately chief of the Southern Party of the expedition, representing the expedition. Each member of the committee was made responsible for the editing of reports in his own section, and Dr. R. M. Anderson was appointed general editor of the reports. This committee has been at work for nearly three years, but owing to the difficulty of securing the services of the fifty or more competent specialists needed to work up the reports, on account of the exigencies of war and other reasons, the first of the technical reports was not issued from the press until July 10, 1919.

These biological reports, and to a large extent the geological and ethnological reports which it is hoped will follow them, were mainly the results of the work of the scientists of the Southern Party of the expedition, owing to the unfortunate death or elimination from work of most of the scientific staff of the Northern Party of the expedition and the total loss of their collections with the *Karluk* in 1914. As a result the later activities of the remainder of that party were practically all geographical and other work and collections merely incidental. The small amount of fragmentary material which was brought back in 1918 has in most cases been included in the reports issued, but in some cases a separate paper will be issued.

The plan adopted by the committee is to issue the report on each group or subject as a separate paper, of the regular octavo size which has been found to be the most convenient and popular for modern scientific papers. Most of the papers are illustrated by line drawings or half-tone engravings from photographs, and in some cases by heliotype or colored plates, illustrating many new species and a few new genera. These papers are mostly too technical to be of interest to the general reader, and the separates are intended to be distributed at time of issue to specialists interested in the particular branch covered, and 1,000 copies of each paper are to be kept by the government and bound into volumes for distribution to public libraries, universities, colleges and other scientific institutions. Eight volumes have been arranged for the biological series, including reports on mammalogy, ornithology, ichthyology and invertebrate marine biology, entomology and botany, and the parts as issued are numbered as parts of these volumes. They are not issued in consecutive order, but each part is printed as it is ready, in order to avoid delay in making the knowledge available to the scientific world and to the public. The amount of specimens and data available and the character and scientific reputation of the specialists engaged in the work promise to make this the most extensive and comprehensive publication on Canadian and western Arctic biology since Richardson and Swainson's "Fauna Boreali-Americana" (1829–31) and Hooker's "Flora Boreali-Americana" (1840).

The volumes in preparation are as follows:

Volume I: General Introduction and Narrative.
 A. Northern Party.
 B. Southern Party.
Volume II: A. Mammals. B. Birds.
Volume III: Insects. (10 parts.)
Volume IV: Botany. (Cryptogams) (5 parts).
Volume V: Botany. (Phanerogams.)
Volume VI: Fishes, Tunicates, etc. (2 parts.)
Volume VII: Crustacea. (12 parts.)
Volume VIII: Mollusks, Echinoderms, Coelenterates, etc. (9 parts.)
Volume IX: Annelids, Parasitic Worms, Protozoans, etc. (12 parts.)
Volume X: Plankton, Hydrography, Tides, etc.

Eleven of the separate parts of the different volumes have been issued:

*Volume III.—Insects:*

Part A—Collembola, by Justus W. Folsom. July 10, 1919.

Part B—Neuropteroid Insects, by Nathan Banks. July 11, 1919.

Part C—Diptera. July 14, 1919.

Crane-flies, by Charles P. Alexander.

Mosquitoes, by Harrison G. Dyar.

Diptera (excluding Tipulidae and Culicidae), by J. R. Malloch.

Part D—Mallophaga and Anoplura. September 12, 1919.

Mallophaga, by A. W. Baker.

Anoplura, by G. F. Ferris and G. H. F. Nuttall.

Part E—Coleoptera. December 12, 1919.

Forest Insects, including Ipidae, Cerambycidæ, and Buprestidæ, by J. M. Swaine.

Carabidæ and Silphidæ, by H. C. Fall.

Coccinnellidæ, Elateraidæ, Clerysomelidæ and Rhynchophora, by C. W. Leng.

Dystiscidæ, by J. D. Sherman, Jr.

Part F—Hemiptera, by E. P. Van Duzee. July 11, 1919.

Sawflies, by Alex. D. MacGillivray.

Parasitic Hymenoptera, by Charles T. Brues.

Wasps and Bees, by F. W. L. Sladen.

Plant Galls, by E. Porter Felt.

Part G—Hymenoptera and Plant Galls, November 3, 1919.

Sawflies, by Alex. D. MacGillivray.

Parasitic Hymenoptera, by Chas. T. Brues.

Wasps and Bees, by F. W. Sladen.

Plant Jalls, by E. P. Felt.

Part H—Spiders, Mites and Myriapods. July 14, 1919.

Spiders, by J. H. Emerton.

Acarina, by Nathan Banks.

Chilopoda, by Ralph V. Chamberlin.

*Volume VII.—Crustacea.*

Part A—Decapod Crustaceans, by Miss Mary J. Rathbun. August 18, 1919.

Part B—Schizopod Crustaceans, by Waldo L. Schmitt. September 22, 1919.

*Volume VIII—Mollusks, Echinoderms, Coelenterates, etc.*

Part A—Mollusks, Recent and Pleistocene, by Wm. Healey Dall. September 24, 1919.

*Volume IX.—Annelids, Parasitic Worms, Protozoans, etc.*

Part A—Oligochaeta, by Frank Smith and Paul S. Welch. September 29, 1919.

## THE AMERICAN SOCIETY OF NATURALISTS

THE thirty-seventh annual meeting of the American Society of Naturalists was held in Guyot Hall, Princeton University, on December 30 and 31, 1919.

The report of the treasurer showing a balance on hand of $327.33 was accepted.

The following changes in the constitution, recommended by the executive committee, were authorized.

Article III., Section 1, to read: The officers of the society shall be a president, a vice-president, a secretary and a treasurer. These, together with three past-presidents and the retiring vice-president, shall constitute the executive committee of the society.

Article III., Section 2, to read: The president and vice-president shall be elected for a term of one year, the secretary and treasurer for a term of three years. Each president on retirement shall serve on the executive committee for three years. Each vice-president on retirement shall serve on the executive committee for one year. The election of officers shall take place at the annual meeting of the society, and their official term shall commence at the close of the meeting at which they are elected.

On recommendation of the executive committee the society accepted an invitation from the National Research Council to appoint an advisory committee to act with the Division of Biology and Agriculture. The following were elected to this committee: Herbert S. Jennings, Alfred G. Mayor, George H. Shull, Ross G. Harrison, Bradley M. Davis.

A request for financial support from the management of Botanical Abstracts was discussed by the society with the result that a motion was carried to the effect that such appropriations were against the general policy of the American Society of Naturalists.

On motion the society approved of the appointment by the chair of a committee to consider and report on genetic form and nomenclature. This committee consists of Clarence C. Little, Donald F. Jones, Sewall Wright, Alfred H. Sturtevant and George H. Shull.

The following resolution presented by Charles B. Davenport and strongly supported from the floor was adopted.

WHEREAS, A current index of scientific publications is necessary to the progress of science and

can be conducted properly only by bibliographers of experience, and at great expense; and

WHEREAS, The Concilium Bibliographicum of Zurich has for a quarter of a century maintained a valuable and unique service in international bibliography, especially in the fields of zoology, physiology, vertebrate anatomy and general biology; has continued the bibliography of Engelmann and Carus which covers the period from 1700 to the present; and has maintained a service of general bibliographic information; and

WHEREAS, the sciences named are the pure sciences upon which the science of medicine rests;

*Therefore resolved*, that the American Society of Naturalists (which has in the past made such subsidies to the Concilium as it could afford) cordially endorses the effort of the Concilium Bibliographicum to secure adequate financial support in this country.

There was elected to honorary membership in the society, William Bateson, John Innes Horticultural Institute, England.

The following were elected to membership: Joseph C. Arthur, Purdue University; Henry C. Cowles, University of Chicago; William Crocker, University of Chicago; Herbert M. Evans, University of California; Edward M. Freeman, University of Minnesota; Aleš Hrdlička, United States National Museum; Clarence M. Jackson, University of Minnesota; Warren H. Lewis, Johns Hopkins Medical School; Ann H. Morgan, Mount Holyoke College; John T. Patterson, University of Texas; Everett F. Phillips, United States Department of Agriculture; Donald Reddick, New York State College of Agriculture; Jacob R. Schramm, New York State College of Agriculture; Homer L. Shantz, United States Department of Agriculture; Henry B. Ward, University of Illinois.

The following program was presented at the morning session of December 30:

*Causes of variation in sex ratio of the wasp, Hadrobracon:* P. W. WHITING.

*Population and race in the Pacific area:* W. E. RITTER.

*The evolution of Pacific coral reefs:* A. G. MAYOR.

*The relative importance of heredity and environment in determining the piebald pattern of guinea-pigs:* SEWALL WRIGHT.

*Relations between nuclear number, chromatin mass, cytoplasmic mass and shell characteristics in Arcella:* R. W. HEGNER.

*The function of the striae in the rotation of the Euglenoids and the problem of evolution:* L. B. WALTON.

*Iodine and the thyroid:* W. W. SWINGLE.

*Selective fertilization in pollen mixtures:* D. F. JONES.

*Changing by castration the hen-feathered into the cock-feathered condition:* T. H. MORGAN.

*Application of the chromosome theory to embryonic differentiation:* E. G. CONKLIN.

The session of the afternoon of December 30 consisted of a symposium on *Some relations of biology to human welfare.*

*The theoretical problems of forestry:* RAPHAEL ZON.

*Biology in relation to ethics:* W. E. RITTER.

*Biology and society:* W. M. WHEELER.

*The significance of some general biological principles in public health problems:* RAYMOND PEARL.

*General biology in its relation to medicine:* H. E. JORDAN (read by title.)

The program of December 31 consisted of the following papers:

*A type of primary non-disjunction in Drosophila melanogaster:* A. H. STURTEVANT.

*A sex-linked recessive linkage variation in Drosophila melanogaster:* C. B. BRIDGES.

*A race of Drosophila willistoni giving a shortage of females:* D. E. LANCEFIELD AND C. W. METZ.

*Mutants and mutability in different species of Drosophila:* C. W. METZ.

*Two hereditary tumors in Drosophila:* MARY B. STARK.

*Inheritance of the rubricalyx character in Œnothera:* G. H. SHULL.

*An analysis of an intergrading sex character:* A. M. BANTA AND MARY GOVER.

*Precocious development in Salpa: a biological not a utilitarian phenomenon:* M. M. METCALF (read by title.)

*Ontogeny versus phylogeny in the development of the sensory apparatus in mammalian embryos:* H. H. LANE.

*The influence of alcoholized grandparents upon the behavior of white rats:* E. C. MACDOWELL AND E. M. VICARI.

*Evidence of specific evolution in the genus Partula in the Society Islands:* H. E. CRAMPTON.

*Inheritance of flower form in Phlox Drummondii:* J. P. KELLY.

*An extra chromosome in Camnula pellucida; variations in the number of chromosomes within the testis:* MITCHEL CARROLL.

*Inheritance of milk production and butter-fat percentage as shown by first generation hybrids between the dairy and beef breeds of cattle:* J. W. GOWEN.

*The vascular anatomy of dimerous and trimerous seedlings of Phaseolus vulgaris:* J. ARTHUR HARRIS, E. W. SINNOTT AND J. Y. PENNYPACKER.

*Genetic investigations in Crepis:* E. B. BABCOCK (read by title.)

*Relationships among the genes for color variation in rodents:* L. C. DUNN (read by title.)

*Dice casting and pedigree selection:* H. H. LAUGHLIN.

*Known matings in a species with heteromorphic homologous chromosomes; recombinations obtained in $F_1$ and $F_2$:* E. ELEANOR CAROTHERS.

*The relation of the somatic chromosomes in Œnothera Lamarckiana and O. gigas:* R. T. HANCE.

*Concerning the inheritance of broodiness in domestic fowl:* H. D. GOODALE (read by title.)

*Heredity of twining from the paternal side:* C. B. DAVENPORT.

*Notes on the human sex ratio:* C. C. LITTLE.

*An experiment on regulation in plants:* E. N. HARVEY (read by title.)

*A series of allelomorphs in Drosophila with nonquantitative relationships:* H. J. MULLER.

*The rate of evolution:* E. G. CONKLIN.

The Naturalists' dinner was held on the evening of December 30 in the dining hall of the Graduate School of Princeton University with eighty-two in attendance. The presidential address by Edward M. East was entitled "Population."

The officers of the society for 1920 are:

*President*—Jacques Loeb, Rockefeller Institute for Medical Research.

*Vice-president*—Bradley M. Davis, University of Michigan.

*Secretary*—A. Franklin Shull, University of Michigan (1920–22).

*Treasurer*—J. Arthur Harris, Carnegie Station for Experimental Evolution (1918–20).

*Additional members of the Executive Committee*—John H. Gerould, Dartmouth College (1920); George H. Shull, Princeton University (1918–20); William E. Castle, Harvard University (1919–21); Edward M. East, Harvard University (1920–22).

BRADLEY M. DAVIS,
*Secretary*

## THE AMERICAN PHYSICAL SOCIETY

THE twenty-first annual meeting (the 101st regular meeting) of the American Physical Society was held at Soldan High School in St. Louis, Missouri, on December 30, 31, 1919, and January 1, 1920, in affiliation with Section B—Physics—of the American Association for the Advancement of Science.

At the business session held on December 31, 1919, officers for 1920 were elected as follows:

*President*—J. S. Ames.

*Vice-president*—Theodore Lyman.

*Secretary*—D. C. Miller.

*Treasurer*—G. B. Pegram.

*Managing Editor*—F. Bedell.

*Councillors*—F. B. Jewett and Max Mason.

*Members of the Editorial Board*—E. L. Nichols, C. M. Sparrow and W. F. G. Swann.

The question of the relation of the society to the work of the trustees for the Preparation of Critical Tables of Physical and Chemical Constants was brought before the society; after discussion it was, by general consent, referred to the president, the councillor and the trustee representing the society, for such action as may seem best.

At the meeting of the council held on December 30, 1919, the following elections were made: to *regular membership,* T. H. Gronwall, E. H. Kennard, Henry A. McTaggart; to *associate membership,* William H. Agnew, W. H. Bair, Vola P. Barton, Henry M. Brook, J. T. Lindsay Brown, John A. David, E. C. Gaskill, Charles W. Henderson, F. F. Householder, Teizo Isshiki, Charles S. Jewell, P. Kirkpatrick, F. W. Kranz, Charles P. Miller, George S. Monk, Chalmer N. Patterson, Herbert J. Plagge, Geo. E. Raburn, S. P. Shackleton, George C. Southworth, John Alden Terrell, John A. Tobin, A. P. Vanselow, E. E. Zimmerman; *transferred from associate to regular membership,* Harold D. Babcock, Clifton G. Found, R. C. Gibbs, J. A. Gray, Frank B. Jewett, Edwin C. Kemble, Fred Loomis Mohler, Lindley Pyle, C. V. Raman, Paul E. Sabine, F. B. Silsbee, Elmer H. Williams.

On Tuesday afternoon, December 30, 1919, the president, J. S. Ames, delivered an address on "Einstein's theory of gravitation and some of its consequences." This was a masterly presentation of the development and conclusions of this theory, and it was listened to by the largest audience of the meetings.

The session on the afternoon of Wednesday, December 31, 1919, was under the auspices of Section B—Physics—of the American Association of the Advancement of Science. The retiring chairman of Section B, Dr. G. F. Hull, gave an address on "Some aspects of physics in war and peace." Following this there was a symposium of four special papers on "Phenomena in the ultra-violet

spectrum, including X-rays,'' by R. A. Millikan, D. L. Webster, Wm. Duane and A. W. Hull.

The programs consisted of thirty-four papers, six of which were read by title only, presented at four different sessions. The program of eight papers given at the session of Wednesday morning, consisted exclusively of papers relating to acoustics. The average attendance was about eighty-five, the maximum being about one hundred and twenty-five. The program was as follows:

*Variation of transparency to total radiation with temperature of source:* S. Leroy Brown.

*The dissipation of heat by various surfaces in still air:* T. S. Taylor.

*The influence of air velocity and the angle of incidence on the dissipation of heat:* T. S. Taylor.

*The measurement of thermal expansion of metals at ordinary temperatures:* Charles D. Hodgman.

*A method for determining the photographic absorption of lenses:* G. W. Moffitt.

*Defects in centered quadric lenses:* Irwin Roman.

*The sinker method applied to the rapid and accurate determination of specific gravities:* N. W. Cummings. (Read by title.)

*Amplification of currents in the Bunsen flame:* C. W. Heaps.

*A new type of non-inductive resistance:* H. L. Dodge.

*Some laboratory uses for the contract rectifier:* J. C. Jensen.

*An undamped wave method of determining dielectric constants of liquids:* W. H. Hyslop and A. P. Carman. (Read by title.)

*Difficulties in the theory of rain formation:* W. J. Humphreys.

*A physical theory of ocean or reservoir temperature distributions, regarded as effects of solar radiation, evaporation and the resulting convection:* Geo. F. McEwen.

*Electromagnetic induction and relative motion:* W. F. G. Swann.

*The influence of blowing pressure on pitch of organ pipes:* Arthur C. Lunn.

*A photographic study of explosions in gases:* John B. Dutcher.

*A photographic study of sound pulses through crooked and curved tubes, with deductions concerning telephone mouthpieces, phonograph horns, etc.:* Arthur L. Foley.

*A photographic method of measuring the instantaneous velocity of sound waves at points near the source:* Arthur L. Foley.

*A possible standard of sound—I., study of operating conditions; II., study of wave form:* Chas. T. Knipp.

*The performance of conical horns:* G. W. Stewart.

*A photographic study of the wave-form of sounds from large guns in action:* Dayton C. Miller.

*The calibration of a sound chamber and sound sources and the measurement of sound transmission of simple partitions:* Paul E. Sabine.

*Transmissions of sound through walls:* F. R. Watson.

*Charcoal absorption and cyclic changes:* Thos. E. Doubt.

*The heat of vaporization and work of ionization:* C. S. Fazel. (Read by title.)

*Energy content of characteristic radiations:* Chester W. Rice.

*The spectrum of radium emanation:* R. E. Nyswander, S. C. Lind and R. B. Moore.

*The Zeeman effect for electric furnace spectra:* Arthur S. King. (Read by title.)

*Critical potentials of the ''L'' series of platinum:* David L. Webster.

*On the possibility of pulling electrons from metals by powerful electric fields:* R. A. Millikan and B. E. Shackelford.

*On the recoil of Alpha particles from light atoms:* L. B. Loeb. (Read by title.)

*Reactive hydrogen in the electrical discharge:* Gerald L. Wendt and Robert S. Landauer. (Read by title.)

*The construction and design of a device permitting the application of a current pulse for a predeterminate number of milliseconds:* Lyndley Pyle.

*The spectral transmission of various glasses:* Henry P. Gage.

Dayton C. Miller,
*Secretary*


# SCIENCE

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